THE

ONTARIO WATER RESOURCES

COMMISSION

PRELIMINARY STUDY OF THE

PROBLEM OF

PULP AND PAPER MILL EFFLUENT DISCHARGES

TO THE OLD WELLAND CANAL

IN THE THOROLD/ST. CATHARINES AREA

March, 1970

Division of Industrial Wastes

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SUMMARY

Alternative solutions to the problem created by mill waste discharges to the Old Welland Canal in Thorold/St. Catharines are considered.

It is concluded that the most feasible solution to the problem is translocation of partially treated wastes by pipeline for discharge into either Twelve Mile Creek or Lake Ontario via a diffuser outfall. The estimated cost of this scheme is approximately 15 million dollars.

Joint treatment of the mill waste effluents in a centrally located treatment plant or together with municipal wastes in a municipal treatment plant will require a large capital investment, estimated to be approximately 23 million dollars. The associated operating costs to the mills for this type of scheme will be considerable and could, in some cases, render the mill operations uneconomic.

It is doubtful whether the degrees of efficiency required by individual treatment plants treating each mill waste separately prior to discharge to the Old Canal could be achieved to provide an acceptable level of water quality in the Old Canal.

The volume of dilution water required to produce an acceptable quality of water in the Old Welland Canal is estimated to be 3000 cfs. It is doubtful whether this volume of water is available from the present canal.

It is possible that a combination of waste treatment at individual mills and dilution in the Old Welland Canal might provide the required water quality in the Old Canal but this will depend on how much water is available for dilution and the resulting water quality in Twelve Mile Creek. The water quality in Twelve Mile Creek could become the limiting factor particularly if water for dilution is

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diverted from the "Hydro" feed canal to the DeCew Falls power stations which discharge to Twelve Mile Creek.

Results of recent samplings of the effluent discharges of the seven mills to the Old Welland Canal and of samples taken along the length of the canal are appended for information purposes. It should be noted that these samples were only grab samples and, therefore, the results are not necessarily indicative of prevailing values.

INTRODUCTION

There are presently seven pulp and paper mills operating in the Thorold/St. Catharines area:

1. The Beaver Wood Fibre Company, Limited - Thorold

   Processes: groundwood pulp from peeled logs
   sulphite pulp purchased.

   Production: 120 tons/day newsprint
   180 tons/day board

2. The Ontario Paper Company Limited - Thorold

   Processes: groundwood pulp (no barking)
   sulphite pulp

   Production: 760 tons/day newsprint and sulphite pulp

3. Domtar Construction Materials Ltd. - Thorold

   Processes: waste paper, wood wastes, etc.

   Production: 50 tons/day roofing felt

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4. Abitibi Provincial Paper Ltd. - Thorold

Processes: deinking of waste paper

Production: 252 tons/day fine papers

5. Kimberly-Clark of Canada Limited - St. Catharines

Processes: purchased pulps

Production: 102 tons/day tissue and wrapper

6. Domtar Fine Papers Ltd. - St. Catharines

Processes: purchased pulps

Production: 88 tons/day fine papers

7. Garden City Paper Mills Company, Limited - St. Catharines

Processes: purchased pulps

Production: 28 tons/day parchment and fine papers

These seven mills now find themselves located in a growing urban environment where the discharge of untreated mill waste effluents into open watercourses will no longer be tolerated by the public.

The purpose of this preliminary report is to define the present problems associated with the discharges of untreated and partially treated mill waste effluents to open watercourses in the Thorold/St. Catharines area and to explore some possible solutions to these problems.

MILL WASTE DISCHARGES

Waste effluents from the Beaver Wood Fibre mill are discharged directly into Beaver Dams Creek, on the east side of the present Welland Canal. Dilution

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water from the canal is mixed with the wastes in the creek and the whole is transported via a syphon under the canal to discharge on the west side of the canal into Beaver Dams Ponds. The Beaver Dams Ponds/Lake Gibson complex is used by Ontario Hydro as a storage reservoir for the DeCew Falls generating stations and during periods when the water level is high, it is necessary to pump the waters from the discharge of the syphon into the Lake. The "Hydro" has installed a small lift pump station for this purpose.

All waters from the Beaver Dams Ponds/Lake Gibson complex discharge via the two DeCew Falls generating stations into Twelve Mile Creek.

Wastes from the remaining six mills discharge into the Old Welland Canal, known locally as the "Industrial Waste Channel". All discharges are direct except for Kimberly-Clark and Garden City Paper Mills which discharge into two small creeks which in turn flow into the Old Welland Canal.

The Old Welland Canal is approximately $5\frac{1}{2}$ miles long from its source at the west side of the present canal opposite Ontario Paper in Thorold to its discharge into Twelve Mile Creek in St. Catharines. During the course of this $5\frac{1}{2}$ miles, the canal is covered or subterranean in three stretches which total approximately 42 percent of the canal length. That is, the Old Welland Canal flows as an open ditch for just over 3 miles of its total $5\frac{1}{2}$ mile length.

The source of the Old Welland Canal is comprised of the wastes from the Ontario Paper mill and dilution water from the present Ship Canal. During the course of flow, wastes from the other five mills are added in the order (3) to (7)

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respectively, with the wastes from the last mill, Garden City, entering just prior to Centennial Park.

As part of the 1967 centennial celebrations, the City of St. Catharines constructed a Centennial Park adjacent to the Old Welland Canal. The gross aesthetic pollution of the Old Canal at the present time detracts from the benefits of this park and this has led to public demands for clean-up of the Old Canal.

PROBLEM DEFINITION

Table I indicates waste data for the seven mills in the area, projected for March 1970. The data are basically taken from the Fourth Quarter 1969, quarterly effluent reports submitted by the mills but have been adjusted to allow for the removal of suspended solids by the clarifiers recently brought into continuous service at the Ontario Paper and Abitibi Provincial mills.

The data in this table indicate that the Ontario Paper mill contributes the largest single sources of waste flow and BOD_5 to the Old Canal. The Abitibi Provincial mill is second and actually constitutes the largest source of suspended solids.

Taking allowance of the dilution water which is fed into the Old Canal at the source but not allowing for any other waste flows or storm drain flows except for the mill wastes, it is possible to calculate the approximate BOD_5 and suspended solids concentrations which accumulate in the canal and which are discharged into Twelve Mile Creek. (There may be a slight decrease in BOD_5 due to biological activity along the length of the canal but this is considered insignifi-

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cant.) These values are 244 ppm and 98 ppm, respectively.

Other significant forms of pollution in the Old Canal are, however, colour and foam. The water in the canal is a dark brown colour and thick white foams exist along most of the length. It is generally agreed that the colour and foam originate from the spent sulphite pulping liquors of the Ontario Paper mill. The Company has announced its intention to install facilities to treat spent sulphite liquors and remove them from the waste discharges. When this is done, the aesthetics of the canal should improve considerably although there will still remain substantial concentrations of BOD_5 and suspended solids, and colours from the dyes used in fine paper and tissue manufacture could still present problems.

In the case of the Beaver Wood Fibre discharges, the problem is not so severe because of the relative inaccessibility of the area in the vicinity of the syphon discharge. However, the waste discharges generally have an unappealing greyish colouration and contain large quantities of suspended material.

At most mills, the sanitary wastes have been segregated from mill wastes and are discharged to municipal sewers. In some cases, segregation is not complete or a municipal sewer is not available. There are, therefore, still some sanitary wastes discharged to the Old Canal.

PROBLEM SOLUTIONS

It is possible to conceive a number of alternative solutions to the problems associated with these mill wastes but the solutions will be dependant on the objectives or goals desired.

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To generate a number of solutions which will be considered below, the following objective or goal has been used:

OBJECTIVE: "To upgrade the water quality in the Old Welland Canal to an 'acceptable' level and at the same time to ensure that a satisfactory waste disposal system for the pulp and paper mills will be provided without degrading the quality of water in any alternative receiving waters which might be considered".

The definition of the term 'acceptable' has not been included. Rather, it is intended to indicate various levels of water quality in the Old Canal which can be achieved by alternative solutions.

The use of this objective precludes the closing down of mills as a reasonable solution. However, it may be necessary to include this solution if a strict economic analysis is to be performed to derive benefit-cost ratios.

SOLUTION 1

Ontario Paper Company to Reduce Its BOD_5 by 70% (Copeland) and All Mills to Reduce Suspended Solids to 50 ppm Level

Figure II indicates the waste data under these conditions. Again, it is noted that the wastes from Ontario Paper Company constitute the largest single source. However, with a Copeland System installed, the dark brown discolouration and heavy foam in the Old Canal will disappear. Under these conditions, it is estimated that the BOD_5 and suspended solids concentrations in the Old Canal will be 118 ppm and 33 ppm, respectively. Colour from the dyes used in fine paper manufacture may continue to cause aesthetic pollution and it is difficult to comment on the acceptability of the water quality under these conditions. We do know from

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a previous time when Ontario Paper Company's wastes were diverted that the quality in the Old Canal was described as "considerably improved" although by most people's standards it would still be grossly polluted.

To achieve this quality, treatment facilities will be required at all six mills.

The installed clarifier and the Copeland System to be installed at Ontario Paper Company will cost approximately 5 million dollars.

The clarifier at Abitibi Provincial does not remove sufficient suspended solids and it is not known at this time how better efficiency can be achieved. The Company is investigating methods of improving the solids removal which we will assume can be accomplished at an additional cost to the Company of $500,000.

Clarifiers will be required at Domtar Fine Papers and Kimberly-Clark at a cost of approximately $500,000 each. Similarly, to clarify the wastes from the Domtar Construction mill and Garden City Paper Mills could cost approximately $500,000 in each case.

The total cost to the six mills discharging wastes to the Old Canal is estimated, therefore, to be approximately 7.5 million dollars.

Operating costs cannot be calculated but clarifier sludge disposal could be a very large item of expense.

The cost to Beaver Wood Fibre to reduce the suspended solids to 50 ppm is not known. The Company is installing a new board machine to replace the two present machines and is planning to use the existing disc filter in a whitewater

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re-use circuit. However, it is reasonable to assume that a clarifier will be required at an estimated cost of $500,000.

Summary

Cost to six mills to achieve a water quality in the Old Canal of 118 ppm BOD_5 and 33 ppm suspended solids is estimated to be 7.5 million dollars. An additional $500,000 will be required by Beaver Wood Fibre to achieve 50 ppm suspended solids.

SOLUTION 2

Dilution of Wastes in the Old Welland Canal

With Ontario Paper Company reducing its BOD_5 by 70% and using the BOD_5 data in Table II for wastes discharged to the Old Canal, it is possible to calculate the amount of dilution water required to produce a BOD_5 of 4 ppm in the Old Canal.

For a BOD_5 loading of 65,500 lbs./day, the total flow required

$$= \frac{65{,}000 \text{ mgd}}{10 \times 4}$$

$$= 1640 \text{ mgd}$$

Total waste flow = 36 mgd

So dilution water required = 1600 mgd

= 3000 cfs

It is reasonable to conclude that the St. Lawrence Seaway Authority would not permit this much water to be drawn from the present Ship Canal and also that a flow of this magnitude could create a raging torrent in the Old Canal with associated

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safety hazards. There is also the possibility that the Old Canal could not handle a flow of this magnitude without flooding and the Ontario Hydro would likely react unfavourably to such a proposal because it would represent a loss of power.

The cost of this scheme is unknown but is believed that new facilities to feed this amount of dilution water to the Old Canal would have to be constructed because the existing dilution water facilities are too small.

With a total existing flow in the Old Welland Canal of approximately 55 mgd, the maximum allowable BOD_5 loading which will restrict the BOD_5 concentration to 4 ppm or less can be calculated:

Maximum allowable BOD_5 loading = $4 \times 55 \times 10 = 2200$ lbs./day

This means that the six mills in question would have to reduce the total BOD_5 output by $\frac{(65,500 - 2200)}{65,500} \times 100 = 96.5\%$

This is equivalent to each mill reducing the concentration of BOD_5 in its effluent to approximately 6 ppm and, therefore, this solution can be discounted as being unfeasible.

SOLUTION 3

Translocation of Wastes by Pipeline to Alternative Points of Discharge

A cursory glance at a map of the Thorold/St. Catharines area will show that there are only two watercourses of sufficient size to warrant consideration as receiving watercourses for the wastes of the pulp and paper mills. These two are Twelve Mile Creek below the DeCew Falls "Hydro" complex and Lake Ontario.

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Each of these alternatives will be examined briefly below:

SOLUTION 3a

Pipeline to Twelve Mile Creek Utilizing the Route of the Existing Old Welland Canal

The Old Canal from its source at Ontario Paper to its point of discharge into Twelve Mile Creek is approximately 30,000 feet in length. Let us assume that it would be feasible to construct a closed conduit pipeline along the bed of the canal for the specific purpose of conveying only the paper mill wastes from the mills for discharge into Twelve Mile Creek.

The total waste flow of the six mills under consideration is approximately 40 mgd. A gravity conduit to handle this volume of discharge will cost an estimated $100 per foot of length to install.

Therefore, cost of the pipeline = 30,000 x $100 = $3 million

In addition, it will be necessary to make the connections from Garden City Mills and Kimberly-Clark which will require extra piping and also to install a diffuser outfall on the end of the pipe to disperse the wastes into Twelve Mile Creek. The cost of these items can probably be absorbed in the $3 million estimate.

It is necessary to consider the assimilative capacity of Twelve Mile Creek along with the installation of the pipeline. Using the BOD_5 data from Table II, which assumes a 70 percent reduction at Ontario Paper, the total BOD_5 loading presently discharged to Twelve Mile Creek via the Old Welland Canal and Beaver Dams Ponds is approximately 73,000 lbs./day in a total combined flow of approximately 40 mgd.

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It was learned from Ontario Hydro that the volumes of water used at the two DeCew generating stations vary according to power demand and that a minimum flow condition exists for about 4 hours at night, i.e., for approximately 15 percent of the time.

This minimum flow is estimated to be 2270 cfs or 1460 mgd.

Under these conditions of minimum flow, the average BOD_5 concentration in Twelve Mile Creek which will result from the discharge of the mill wastes can be calculated.

$$\text{Average } BOD_5 \text{ concentration} = \frac{75{,}000}{(1460 + 40)} \times 10 = 5 \text{ ppm}$$

A level of increase of this magnitude is generally considered to be unacceptable and in this case, because other industrial and municipal wastes are added to the creek downstream, let us assume that the maximum acceptable level of increase is 2 ppm BOD_5.

Under these conditions, the maximum allowable BOD_5 loading in the combined mill discharges would be:

$$2 \times 1500 \times 10 = 30{,}000 \text{ lbs./day}$$

To achieve this level of BOD_5 loading, the gross loadings from the mills would have to be reduced by:

$$\frac{75{,}000 - 30{,}000}{75{,}000} = \underline{60 \text{ percent}}$$

A reduction of approximately 60 percent in the BOD_5 of the four largest contributors will probably accomplish this desired 60 percent overall reduction.

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For example:

Ontario Paper	- from	27,000 lbs. to	10,800 lbs.
Abitibi Provincial	- from	30,000 lbs. to	12,000 lbs.
Beaver Wood Fibre	- from	7,400 lbs. to	3,000 lbs.
Domtar Fine Papers	- from	5,500 lbs. to	2,200 lbs.
		Total	28,000 lbs.
		Other Mills	3,000 lbs.
		Daily Gross Total	31,000 lbs.

Let us now examine the cost of treatment for each of these four mills to reduce the BOD_5 loading by an additional 60 percent and let us assume that because of space restrictions, only the activated sludge process can be used:

(a) Ontario Paper

Most of the BOD_5 will be associated with condensates from the spent sulphite liquor treatment system. Assume that the flow of condensates is 1 mgd. Estimated capital cost for treatment = 48 cents per gallon per day. Allow a factor of 1.5 for escalation of costs. Estimated present capital cost (1970) for treatment works:

$$\frac{1.0 \times 10^6 \times 48 \times 1.5}{100} = \$720,000$$

(b) Abitibi Provincial

Most of the BOD_5 is associated with deinking and bleaching wastes. Assume that the daily volume of these wastes to be treated is 2 million gallons.

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Estimated capital cost for treatment = 45 cents per gallon per day (1965)

Allowing a factor of 1.5 for escalation of costs, estimated 1970 capital cost for treatment works = $\frac{2.0 \times 10^6 \times 45 \times 1.5}{100}$ = $1.3 million

(c) Beaver Wood Fibre

It is difficult to estimate treatment waste data for this mill with the forthcoming installation of a new board machine later this year. However, assume that the volume to be treated is 1 mgd.

Then, estimated capital cost = $720,000 (see a)

(d) Domtar Fine Papers

Assume that the volume of waste to be treated is 1.0 mgd.

Then, estimated capital cost = $720,000 (see a)

The total estimated cost of this scheme which requires the reduction of suspended solids to the 50 ppm level and BOD_5 reduction at four mills are summarized below:

COSTS IN MILLIONS OF DOLLARS

	Primary Treatment	Secondary Treatment	Total
(1) Ontario Paper	1.5	4.3	5.8
(2) Domtar Construction	0.5	--	0.5
(3) Abitibi Provincial	0.5	1.3	1.8
(4) Kimberly-Clark	0.5	--	0.5
(5) Domtar Fine Papers	0.5	0.72	1.22
(6) Gar'en City	0.5	--	0.5
		Sub-Total	10.32
Estimated cost of pipeline to Twelve Mile Creek			3.0
		Total	13.32

The cost of the six mills presently discharging to the Old Welland Canal is estimated to be $13.32 million.

In order to adequately protect the quality of water in Twelve Mile Creek, the Beaver Wood Fibre mill must also treat its wastes. The estimated cost of treatment for this mill is $1.22 million, with $0.5 million for primary treatment and $0.72 million for second treatment.

Therefore, the overall estimated cost of this scheme to the seven mills in the Thorold/St. Catharines area is $14.54 million.

As an alternative to installing a pipeline to convey the wastes, consideration should be given to the possibility of covering over the Old Welland Canal

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along its entire length. The disadvantage of this scheme would be the elimination of a visible body of water in the Centennial Gardens.

It was not possible, within the scope of this report, to obtain a cost figure for covering over the canal along the 3 miles plus which are still open. Presumably a culvert and land fill scheme would be employed and this could be more expensive than a pipeline.

This alternative should be investigated, however, in greater detail by suitably qualified persons.

SOLUTION 3b

Pipeline to Lake Ontario

Under this scheme, a collector trunk sewer and a pipeline would be constructed to translocate the wastes from the seven mills in the area to a suitable point for discharge to Lake Ontario. The wastes would then be dispersed into Lake Ontario by means of a submerged diffuser outfall.

For the purposes of estimation, assume that a pipeline 10 miles long will be required and that two pumping stations will be necessary.

Estimated cost of force main to handle 40 mgd

= $75 per foot

= $75 x 10 x 5280 = $4 million

Two pumping stations @ $1 million each = $2 million

Diffuser outfall = $0.5 million

Total Estimated Cost $6.5 million

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In addition, primary treatment at each mill will be required at an estimated cost of $4.5 million, and Ontario Paper will install a sulphite waste liquor treatment system at a cost of $3.5 million. Overall estimated expenditures required = $14.5 million.

This analysis indicates that the cost of this scheme would be compatible with that of the previous scheme. This scheme has the advantage that mill effluents are discharged directly to Lake Ontario which should result in improved conditions in Twelve Mile Creek and the Martingdale Pond.

SOLUTION 4

Joint Treatment of Total Mill Effluent Discharges in a Centrally Located Treatment Plant

Under this scheme, the total wastes from the seven mills would be treated jointly in a suitably located treatment plant. Because of the difficulties in treating spent sulphite liquors biologically, assume that Ontario Paper will proceed with its proposals to install a treatment system for spent sulphite liquors.

Under these conditions, the characteristics of the wastes to be treated would be:

Flow	- 40 mgd
BOD_5	- 75,000 lbs./day
Suspended Solids	- 54,000 lbs./day

Assume that an activated sludge treatment plant will be constructed to

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handle a flow of 40 mgd.

Estimated cost of this plant (1965) = 27 cents per gallon per day

Using a 1.5 factor for escalation, the 1970 estimated capital cost

$$= \frac{40 \times 10^6 \times 27 \times 1.5}{100} = \underline{\$16.5 \text{ million}}$$

In addition, a collector trunk sewer and effluent discharge pipe and diffuser outfall will be required. The cost for this scheme will be as estimated under Solution 3b), i.e., = $6.5 million

Cost of treatment at Ontario Paper = $5.0 million

Total Estimated Cost of Scheme = $28 million

SOLUTION 5

Joint Treatment With Municipal Wastes in a Municipal Treatment System

This solution essentially resolves down to the same thing as treatment in a joint treatment facility and will still require the installation of trunk collector sewers and pumping stations as the existing municipal facilities are insufficient capacity to handle the mill wastes.

It can be assumed, therefore, that the capital cost of this scheme would also be $28 million. This would be amortized over a period of years and included as part of the annual charges to each mill for handling its wastes.

DISCUSSION

Operating Costs

No estimates for operating costs have been included in the above pro-

posed solutions on account of the difficulty in obtaining any meaningful data. However, operating costs for treatment of pulp and paper mill wastes can be extremely large. The U.S. publication, "The Cost of Clean Water, Volume III", cites operating costs in the range of $1.0 to $5.0 per ton of product. However, these figures apply to bleached kraft or bleached sulfite mills and are not really applicable to the Thorold/St. Catharines mills.

Annual operating costs will include:

(a) Maintenance - structural
- mechanical
- piping

(b) Operating labour

(c) Chemical costs

(d) Power costs

(e) Sludge disposal costs

(Chemical requirements can be quite large because pulp and paper mill wastes are deficient in nitrogen and phosphorous and both these elements are required for biological oxidation systems.)

Data for municipal waste treatment systems in Ontario indicate normal operating costs in the range of 5 to 10 cents per 1000 gallons treated. It is probable that the operating costs for an industrially operated plant would be in the lower range and, therefore, an operating cost figure of 6 cents per 1000 gallons treated has been applied to the seven mills in question to develop the

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anticipated minimum operating costs shown in Table III.

The total cost of treatment will also have to include amortization of the capital cost of $28 million, which is calculated to be 14 cents per 1000 gallons of waste treated for a 50 mgd plant under provincial financing. Estimated total treatment costs on a daily and annual basis, together with the cost per ton of product, are indicated in Table III.

In most cases, the estimated additional costs per ton of product would be greater than those which the industry claims it can tolerate and still maintain a viable operation. Also, in the case of Ontario Paper, these costs will be in addition to the costs of the installed clarifier and proposed Copeland System, and these two items alone could result in a cost of up to $5 per ton of product.

Because of the magnitude of the costs involved here, it is obvious that a more detailed economic study is required and the benefits of cleaning up the Old Welland Canal may be insufficient to justify the expenditures.

Most Reasonable Solution

In summary, five general solutions to the problem were reviewed. These are:

(1) Mills treat down to 50 ppm suspended solids and Ontario Paper to treat spent liquors.

(2) Dilution of wastes in Old Welland Canal.

(3) Translocation of wastes to alternative points of discharge - with individual treatment to required level.

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(4) Joint treatment in central treatment plant.

(5) Joint treatment with municipal wastes in municipal plant.

Solution 1 is deemed unacceptable because it will not produce the desirable quality of water in the Old Welland Canal or in Twelve Mile Creek. In addition, colour from the fine paper mills could cause aesthetic problems. For each individual mill to clean up to a degree which would result in an acceptable water quality level in the Old Welland Canal would require BOD_5 reduction of the order of 96 percent and it is doubtful whether such a level of waste treatment efficiently is attainable.

Solution 2 is deemed unacceptable on two counts. Firstly, it is against OWRC policy to allow "dilution of wastes" where treatment is feasible and secondly, the volume of dilution water required to produce an acceptable quality level is too great. Apart from restrictions by the Federal Government on withdrawing water from the present Welland Canal, a flow of approximately 3000 cfs in the Old Welland Canal could cause problems of flooding and create hazardous conditions in an open-cut channel.

Solution 3 which removes all mill discharges from the Old Welland Canal appears to be the most promising solution both from the cost point of view and the practical point of view. In many respects, it would be preferable to translocate the partially treated wastes directly to Lake Ontario, arranging for suitable dispersion into the Lake. On the other hand, from a practical standpoint, it might be easier to construct a pipeline in the existing bed of the Old Welland Canal and translocate the

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wastes to Twelve Mile Creek. A certain degree of treatment will be necessary at some of the mills in order to ensure an acceptable water quality in the Creek and the degrees of treatment required appear to be within a practical range. A diffuser-type outfall would be required to provide improved dispersion of the treated wastes into the Creek.

Solution 4 joint treatment of all mill wastes in a centralized treatment plant, although having the advantage of removing the wastes from the Old Welland Canal, suffers from the disadvantage of requiring a large capital cost investment for the mills in question. In addition, there are problems associated with the physical location of such a plant. It is reasonable to conclude that the effluent from the treatment plant could only be discharged to two watercourses: Twelve Mile Creek or Lake Ontario. This places severe restrictions on the selection of suitable sites.

However, if the government, at one or all levels, could provide some financial assistance, this solution might still merit consideration.

Solution 5 In a large municipal area, joint treatment of domestic and industrial wastes is an obvious solution to any industrial waste problem. However, in the Thorold/St. Catharines area, the existing municipal facilities are insufficient to handle the wastes from the mills. It is conceivable that one or two of the smaller mills' wastes could be handled by the existing municipal facilities but this does little to solve the problem of the Old Welland Canal.

If new or expanded facilities and collector sewers are required then

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this solution requires a similar order of capital expenditures as solution 4, with the only difference being that the capital cost is borne by the municipality or the government. This capital cost would be reflected back to the mills in taxes and sewer discharge surcharges which, based on experience elsewhere, would result in very large increased operating costs to the mills. It is doubtful whether many of the mills could remain viable operations if burdened with costs of this kind. It is probable that the public will have to bear some of the financial burden directly, either through increased taxes or some alternative scheme, if a system of joint treatment is to become feasible.

The possibility of discharging the treated wastes from Ontario Paper into the Beaver Dams Ponds/Lake Gibson complex was also considered. Upon further analysis, it turns out that consideration of the water quality in Twelve Mile Creek is still the governing factor and this solution becomes much the same as solution 2. In addition, there would be real danger of creating severe pollution in Beaver Dams Ponds/Lake Gibson which presently do have some recreational value.

However, the possibility of diverting the treated wastes from Ontario Paper away from the Old Welland Canal in this manner should not be disregarded in future studies because of a possible benefit in costs.

Combinations of various levels of waste treatment at individual mills together with the addition of various amounts of dilution water to the Old Canal should be considered also. The feasibility of such a scheme will largely depend

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on the amount of dilution water available and the acceptability of the resulting water quality in Twelve Mile Creek.

The bulk of the flow in Twelve Mile Creek presently comes from the discharges from the two generating stations at DeCew Falls and if dilution water from the Old Welland Canal was taken from the "Hydro" requirements, there would be zero change in the net flow in Twelve Mile Creek. Under these conditions, as for solution 3, four mills would have to provide 60 percent reduction in their BOD_5 discharges to ensure a net gain of BOD_5 of less than 2 ppm in Twelve Mile Creek and the only difference from solution 3 would be that the cost of a pipeline would not be required. However, the dilution water required to provide the acceptable quality in the Old Welland Canal under these conditions would be approximately 1400 cfs, based on a BOD_5 loading of 30,000 lbs./day and a maximum BOD_5 concentration of 4 ppm. 1400 cfs represents approximately 20 percent of the maximum flow that "Hydro" is allowed to divert from the present Welland Canal for power generation. It is unlikely that "Hydro" will be prepared to give up 20 percent of its available water and for this reason, this solution has not been seriously considered.

CONCLUSIONS AND RECOMMENDATIONS

From this very brief study of the problem of pulp and paper mill waste discharges in the Thorold/St. Catharines area, it is possible to draw some tentative conclusions. These conclusions will require substantiation by more detailed

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studies before any decisions are made:

(1) It is unlikely that treatment of waste effluents by individual mills prior to discharge into the Old Welland Canal will provide a desirable water quality level in the Old Canal.

(2) As well as being undesirable, the use of additional dilution water in the Old Welland Canal to provide an acceptable water quality is deemed impractical due to the large volume of water which would be required.

(3) Approximately 60 percent reduction in the BOD_5 of the effluent discharges of Ontario Paper (after installation of spent sulphite liquor recovery), Abitibi Provincial, Beaver Wood Fibre and Domtar Fine Papers will be required to provide adequate protection of Twelve Mile Creek if it used as a receiving stream. In addition, all seven mills should provide treatment works for the removal of suspended solids down to the 50 ppm level.

(4) Translocation of partially treated mill wastes by pipeline for discharge into Twelve Mile Creek or Lake Ontario appears to be the cheapest and most practical method to solve the problem of mill waste discharges in the Old Welland Canal.

(5) Joint treatment of the wastes from all seven mills in a central treatment plant or in combination with municipal wastes will require considerable capital investment and could induce large operating costs which the industry may be unable to bear.

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It is recommended that before any further action is contemplated, a firm of consulting engineers be retained to study this problem in greater detail and to provide more accurate cost estimates for the various solutions.

TABLE I

PRODUCTION AND WASTE DATA FOR THE THOROLD/ST. CATHARINES MILLS ESTIMATE FOR MARCH 1970

Company Name	Flow mgd.	BOD_5 1000 lb./day	S.S. 1000 lb./day	BOD_5 ppm	S.S. ppm
Beaver Wood Fibre - Thorold	3.7	8.5	12.0	230	325
Wastes to Beaver Dams Ponds	3.7	8.5	12.0		
Ontario Paper - Thorold	23.6 (65%)	90 (67%)	20 (37%)	380	85
Domtar Construction - Thorold	0.45 (1.2%)	1.1 (0.8%)	0.96 (1.7%)	244	214
Abitibi Provincial - Thorold	6.0 (16.4%)	34.9 (27%)	21 (38.5%)	580	350
Kimberly-Clark - St. Catharines	2.4 (6.6%)	1.4 (1%)	6.0 (11%)	58	250
Domtar Fine Papers - St. Catharines	1.8 (5%)	6.2 (4.5%)	3.6 (6.6%)	345	200
Garden City Mills - St. Catharines	2.1 (5.8%)	0.9 (0.7%)	2.8 (5%)	43	134
Total Wastes to Old Canal	36.35	134.5	54.36		
Dilution Water to Old Canal	19.0				
Total Flow - Old Canal	55.35	134.5	54.36	244	98

NOTE: Percentages of Total Wastes Discharged to Old Canal are Shown in Brackets.

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TABLE II

WASTE DATA ASSUMING ONTARIO PAPER COMPANY REDUCES BOD_5 BY 70% (COPELAND) AND ALL MILLS REDUCE SUSPENDED SOLIDS TO 50 ppm LEVEL (ASSUME 15% BOD_5 ASSOCIATED WITH SOLIDS)

Company Name	Flow mgd.	BOD_5 1000 lb./day	S.S. 1000 lb./day	BOD_5 ppm	S.S. ppm
Beaver Wood Fibre - Thorold	3.7	7.4	1.85	200	50
Wastes to Beaver Dams	3.7	7.4	1.85		
Ontario Paper - Thorold	23.6 (65%)	27.0 (41%)	11.8 (65%)	115	50
Domtar Construction - Thorold	0.45 (1.2%)	1.0 (1.5%)	0.23 (1.3%)	222	50
Abitibi Provincial - Thorold	6.0 (16.4%)	30.0 (46%)	3.0 (16.5%)	500	50
Kimberly-Clark - St. Catharines	2.4 (6.6%)	1.2 (1.8%)	1.2 (6.6%)	50	50
Domtar Fine Papers - St. Catharines	1.8 (5%)	5.5 (8.4%)	0.9 (5%)	310	50
Garden City Mills - St. Catharines	2.1 (5.8%)	0.8 (1.2%)	1.05 (5.8%)	38	50
Total Wastes to Old Welland Canal	36.35	65.5	18.18		
Dilution Water to Old Canal	19				
Total Flow - Old Canal	55.35	65.5	18.18	118	33

NOTE: Percentages of Total Wastes Discharged to Old Canal are Shown in Brackets.

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TABLE III

COST DATA FOR JOINT WASTE TREATMENT PLANT

Company	Production Tons/Day	Flow mgd.	Daily Op. Costs @ 6¢ per 1000 gals - $	Daily Amortization Costs @ 14¢ per 1000 gals - $	Total Daily Cost - $	Cost Per Ton Of Product - $	Total Annual Cost - $
Beaver Wood Fibre	300	3.7	222	518	750	2.46	270,000
Ontario Paper	700	23.6	1416	3304	4720	6.75	1,720,000
Domtar Construction	52	0.45	27	63	90	1.73	32,850
Abitibi Provincial	252	6.0	360	840	1200	4.75	440,000
Kimberly-Clark	102	2.4	144	336	480	4.7	175,000
Domtar Fine Papers	88	1.8	108	252	360	4.1	130,000
Garden City Mills	28	2.1	126	294	420	15	153,000
TOTAL			2403	5607	8010		2,920,850

ONTARIO WATER RESOURCES COMMISSION
CHEMICAL LABORATORIES

INDUSTRIAL WASTE ANALYSIS

All analyses except pH reported in p.p.m. unless otherwise indicated

1 p.p.m. = 1 mgm. / litre
= 1 lb./100,000 Imp. Gals.

Municipality: St. Catharines - Thorold Report to: E.W.C. Turner
P. Diosady
C. Simpson
D. Sturtevant

c.c. Files

Source: Old Welland Canal

Date Sampled: Feb. 10/70 by: RCS/EWCT

br

Lab. No.	5-Day B.O.D.	Solids			pH at Lab.	Lignins & Tannins as Tannic Acid	Phenols in ppb.	Colour Dilution	C.O.D.
		Total	Susp.	Diss.					
T 7-4	600.	3110.	125.	2985.	-	400.	500.	* 1:500	2400.
T 7-5	1.2	190.	10.	180.	7.4	0.	0.	1:2	< 20.
T 7-6	550.	2120.	120.	2000.	7.0	250.	600.	* 1:250	1800.
T 7-7	340.	1800.	115.	1685.	7.5	150.	500.	* 1:200	1300.

* Test performed on filtered samples.

C. Simpson, Analyst,
Supervisor, Chemistry I Branch

P. Diosady, Analyst,
Supervisor, Chemistry II Branch

T 7-4	1.	Ontario Paper Company Limited - Total effluent	Grab 11:00 a.m.
T 7-5	2.	Canal dilution water	Grab 11:30 a.m.
T 7-6	3.	Old well and canal - manhole north of Beaverdams Road	Grab 1:25 p.m.
T 7-7	4.	Old Welland Canal - north of town line road west	Grab 1:05 p.m.

Four (4) duplicate samples each in two 40 oz. bottles marked as above, received in locked box on February 11, 1970, 9:15 a.m.

P. Diosady, Analyst,
Supervisor, Chemistry II Branch

10M-60-22690

ONTARIO WATER RESOURCES COMMISSION
CHEMICAL LABORATORIES

INDUSTRIAL WASTE ANALYSIS

All analyses except pH reported in p.p.m. unless otherwise indicated

1 p.p.m. = 1 mgm. / litre
= 1 lb./100,000 Imp. Gals.

Municipality: St. Catharines - Thorold **Report to:** E.W.C. Turner c.c.

cc P. Diosady
C. Simpson
D. Sturtevant

Source: Old Welland Canal

Date Sampled: Feb. 10/70 **by:** R.C.S., E.W.C.T.

mm

Lab. No.	5-Day B.O.D.	Solids			C.O.D.	pH at Lab	Lignin & Tannins as Tannic	Phenols in ppb	Colour Dilution
		Total	Susp.	Diss.					
T7-8	400.	1800.	150.	1650.	1300.	7.4	150.	500.	* 1:200
T7-9	380.	1790.	120.	1670.	1300.	7.5	150.	500.	* 1:100
T7-10	450.	1920.	175.	1745.	1600.	7.5	200.	800.	* 1:100
T7-11	340.	1530.	175.	1355.	1000.	7.7	150.	300.	* 1:200

* Test performed on filtered sample

C. Simpson, Analyst
Supervisor, Chemistry I Branch

P. Diosady, Analyst,
Supervisor, Chemistry II Branch

T7-8	5	Old Welland Canal - Opposite Allanburg Road	Grab 1.40 p.m.
T7-9	6	" " " - Opposite Chestnut Street West	" 1.50 p.m.
T7-10	7	" " " - At C.N.R. bridge, below Domtar Fine Papers Ltd.	" 2.00 p.m.
T7-11	8	" " " - In Centennial Park 100 feet upstream of creek containing Garden City Wastes.	" 2.25 p.m.

Four (4) duplicate samples each in two 40 oz. bottles marked as above, received in locked boxes on February 11th, 1970, 9.15 a.m.

P. Diosady, Analyst,
Supervisor, Chemistry II Branch

10M-60-22690

ONTARIO WATER RESOURCES COMMISSION
CHEMICAL LABORATORIES

INDUSTRIAL WASTE ANALYSIS

All analyses except pH reported in p.p.m. unless otherwise indicated

1 p.p.m. = 1 mgm. / litre
= 1 lb./100,000 Imp. Gals.

Municipality: St. Catharines - Thorold **Report to:** E.W.C. Turner
cc P.L. Diosady
C.E. Simpson
D. Sturtevant

c.c. Files (rd)

Source: Old Welland Canal and Twelve Mile Creek

Date Sampled: Feb. 10, 1970 **by:** RCS EWCT

Lab. No.	5-Day B.O.D.	Solids			pH at Lab.	Lignins & Tannins as Tannic Acid	Phenols in ppb	Colour Dilution	Turbidity Units	C.O.D.
		Total	Susp.	Diss.						
T7-12	40.	800.	140.	660.	3.1	2.5	12.	1:4	70.	120.
T7-13	120.	1400.	160.	1240.	7.3	120.	200.	*1:100	180.	870.
T7-14	5.0	250.	2.	248.	7.8	0.	10.	1:2	3.	< 20.
T7-15	2.0	250.	5.	245.	7.9	2.	8.	1:10	10.	20.

* Test performed on filtered sample

C.E. Simpson, Analyst,
Supervisor, Chemistry 1 Branch.

P.L. Diosady, Analyst,
Supervisor, Chemistry 11 Branch.

T7-12	9.	Creek containing wastes from Garden City at point of discharge to Old Welland Canal (Grab 2:30 p.m.)
T7-13	10.	Old Welland Canal - Centennial Park opposite hospital (Grab 2:35 p.m.)
T7-14	11.	Twelve Mile Creek at Glendale Avenue (Grab 2:50 p.m.)
T7-15	12.	Twelve Mile Creek at Welland and Vale Road (Grab 3:20 p.m.)

Four (4) duplicate samples each in two 40 oz. bottles labelled as above, received in locked box on February 11, 1970, 9:15 a.m.

P.L. Diosady, Analyst,
Supervisor, Chemistry 11 Branch.

10M-60-22690

ONTARIO WATER RESOURCES COMMISSION
CHEMICAL LABORATORIES

INDUSTRIAL WASTE ANALYSIS

All analyses except pH reported in p.p.m. unless otherwise indicated

1 p.p.m. = 1 mgm. / litre
= 1 lb./100,000 Imp. Gals.

Municipality: Thorold

Report to: J. Luyt
P. Diosady
C. Simpson
D. Sturtevant

c.c. A.T.A.F.

Source: Domtar Construction Materials Limited - Thorold Plant

Date Sampled: Jan. 15/70 by: R. Hawley/J. Luyt

br

Lab. No.	5-Day B.O.D.	Solids			pH	C.O.D.	Tannin & Lignin as Tannic Acid		Phenols in ppb.				
		Total	Susp.	Diss.	at Lab.								
T 3-37	340.	890	350	540	7.2	920	45		100				

C. Simpson, Analyst,
Supervisor, Chemistry I Branch.

P. Diosady, Analyst,
Supervisor, Chemistry II Branch.

T 3-37 1. Main Sewer at Parshall Flume 10:25 p.m.

One sample, in quadruplicate, labelled as above, received in a locked box, at 8:45 a.m., Friday, January 16, 1970.

C. Simpson, Analyst,
Supervisor, Chemistry I Branch.

10M-60-22690

ONTARIO WATER RESOURCES COMMISSION
CHEMICAL LABORATORIES

INDUSTRIAL WASTE ANALYSIS

All analyses except pH reported in p.p.m. unless otherwise indicated

1 p.p.m. = 1 mgm. / litre
= 1 lb./100,000 Imp. Gals.

Municipality: Thorold

Report to: E.W.C. Turner

cc P.L. Diosady
C.E. Simpson
D.P. Sturtevant

c.c.

Source: Abitibi Provincial Paper Ltd.

Date Sampled: Jan. 15/70 by: E.W.C. Turner, R.A.Abbott

mm

Lab. No.	5-Day B.O.D.	Solids			C.O.D.	pH at Lab	Phenols in ppb
		Total	Susp.	Diss.			
T3-19	220.	1750	425	1325	820	8.9	12
T3-20	2.0	220	5	215	< 20	7.8	0
T3-21	360	1740	350	1390	770	9.0	20
					< Less than		

C.E. Simpson, Analyst,
Supervisor, Chemistry I Branch

P.L. Diosady, Analyst,
Supervisor, Chemistry II Branch

T3-19	1	Total Mill effluent from clarifier to sewer	Grab 2.00 p.m.
T3-20	2	Raw Water	Grab 2.00 p.m.
T3-21	3	Total mill effluent from clarifier to sewer	Grab 2.45 p.m.

Three samples (in duplicate), labelled as above, received in a locked box at 8.45 a.m., Friday, January 16, 1970.

C.E. Simpson, Analyst,
Supervisor, Chemistry I Branch

10M-60-22690

ONTARIO WATER RESOURCES COMMISSION
CHEMICAL LABORATORIES

INDUSTRIAL WASTE ANALYSIS

All analyses except pH reported in p.p.m. unless otherwise indicated

1 p.p.m. = 1 mgm. / litre
= 1 lb./100,000 Imp. Gals.

Municipality: St. Catharines

Report to: R. Stewart
P. Diosady
C. Simpson
D. Sturtevant

c.c. A.T.A.F.

Source: Kimberly-Clark of Canada Limited

Date Sampled: Jan. 15/70 by: R. Stewart/P. Chisholm

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Lab. No.	5-Day B.O.D.	Solids			pH at Lab.	Phenols in ppb.	C.O.D.						
		Total	Susp.	Diss.									
T 3-26	150.	440	170	270	7.9	9	330						
T 3-27	150.	400	135	265	7.5	3	250						
T 3-28	110.	420	160	260	7.8	20	290						
T 3-29	2.0	200	15	185	7.8	0	< 20						

C. Simpson, Analyst, Supervisor,
Chemistry I Branch.

P. Diosady, Analyst, Supervisor,
Chemistry II Branch.

T 3-26	5.	Effluent from No. 1 and No. 2 paper machines	Grab 11:10 a.m.
T 3-27	6.	Effluent from No. 3 paper machine	11:15 a.m.
T 3-28	7.	Total effluent to creek	Grab 12:10 p.m.
T 3-29	8.	Raw water	Grab 11:20 a.m.

Four samples, in duplicate, labelled as above, received in a locked box at 8:45 a.m., Friday, January 16, 1970.

C. Simpson, Analyst, Supervisor,
Chemistry I Branch.

10M-60-22690

ONTARIO WATER RESOURCES COMMISSION
CHEMICAL LABORATORIES

INDUSTRIAL WASTE ANALYSIS

All analyses except pH reported in p.p.m. unless otherwise indicated

1 p.p.m. = 1 mgm. / litre
= 1 lb./100,000 Imp. Gals.

Municipality: St. Catharines

Report to: E.W.C. Turner
cc P.L. Diosady
C.E. Simpson
D.P. Sturtevant

c.c.

Source: Domtar Fine Papers Ltd.

Date Sampled: Jan 15/70 by: E. Turner, R.A. Abbott

mm

Lab. No.	5-Day B.O.D.	Solids			C.O.D.	pH at Lab	Phenols in ppb
		Total	Susp.	Diss.			
T3-30	70.	440	125	315	180	9.1	5
T3-31	160.	660	345	315	400	8.0	0
T3-32	1.6	200	10	190	< 30	7.8	0

< Less than

C.E. Simpson, Analyst,
Supervisor, Chemistry I Branch

P.L. Diosady, Analyst,
Supervisor, Chemistry II Branch

T3-30	1	Final outfall to Old Welland Canal	Grab 10.00 a.m.
T3-31	2	Total mill effluent to sewer	Grab 11.15 a.m.
T3-32	3	Raw water before sand filter	Grab 11.20 a.m.

Three samples, in duplicate, labelled as above, received in a locked box at 8.45 a.m., Friday, January 16, 1970.

C.E. Simpson, Analyst,
Supervisor, Chemistry I Branch

10M-60-22690

ONTARIO WATER RESOURCES COMMISSION
CHEMICAL LABORATORIES

INDUSTRIAL WASTE ANALYSIS

All analyses except pH reported in p.p.m. unless otherwise indicated

1 p.p.m. = 1 mgm. / litre
= 1 lb./100,000 Imp. Gals.

Municipality: St. Catharines

Report to: J. Luyt
cc P.L. Diosady
C.E. Simpson
D.P. Sturtevant

c.c.

Source: Garden City Paper Mills Company Limited

Date Sampled: Jan 15/70 by: R. Hawley & J. Luyt

mm

Lab. No.	5-Day B.O.D.	Solids			pH at Lab	Phenols in ppb	C.O.D.	Mineral Acidity as $CaCO_3$	Sulphate as SO_4				
		Total	Susp.	Diss.									
T3-33	48.	300	85	215	7.8	5	190	0.	25.				
T3-34	9.0	*	--	*	2.2	25	50	1030	2500				
T3-35	140.	520	100	420	7.8	12	270	0.	60.				
T3-36	46.	1400	75	1325	2.4	10	120	790	1000				

* Oily, does not dry.

C.E. Simpson, Analyst,
Supervisor, Chemistry I Branch

P.L. Diosady, Analyst,
Supervisor, Chemistry II Branch

T3-33	1	Paper Mill sewer	2.35 p.m.
T3-34	2	Parchment sewer	2.45 p.m.
T3-35	3	Creek upstream of plant (15 ft. upstream of paper mill sewer)	2.40 p.m.
T3-36	4	Creek about 200 ft. downstream of parchment sewer	2.50 p.m.

Four samples, in duplicate, labelled as above, received in a locked box at 8.45 a.m., Friday, January 16, 1970.

C.E. Simpson, Analyst,
Supervisor, Chemistry I Branch

10M-60-22690

ONTARIO WATER RESOURCES COMMISSION
CHEMICAL LABORATORIES

INDUSTRIAL WASTE ANALYSIS

All analyses except pH reported in p.p.m. unless otherwise indicated

1 p.p.m. = 1 mgm. / litre
= 1 lb./100,000 Imp. Gals.

Municipality: Township of Thorold

Report to: R. Stewart
P. Diosady
C. Simpson
D. Sturtevant

c.c.

A.T.A.F.

Source: The Beaver Wood Fibre Company Limited

Date Sampled: Jan. 15/70 by: R. Stewart/P. Chisholm

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Lab. No.	5-Day B.O.D.	Solids			pH at Lab.	C.O.D.	Phenols in ppb.						
		Total	Susp.	Diss.									
T 3-22	220.	1140	350	790	7.7	1100	150						
T 3-23	220.	650	265	385	7.3	640	100						
T 3-24	160.	600	245	355	7.5	510	*						
T 3-25	0.8	200	5	195	7.7	< 20	0						

C. Simpson, Analyst,
Supervisor, Chemistry I Branch.

* Sample exhausted, test could not be performed

< = less than

T 3-22	1.	Effluent over 60" weir	Grab 2:40 p.m.
T 3-23	2.	Effluent over 20" weir	Grab 3:20 p.m.
T 3-24	3.	Sample #2 plus clean water flow	Grab 3:00 p.m.
T 3-25	4.	Raw water	Grab 3:35 p.m.

Three duplicate samples of #1, 2 and 4, and one single sample of #3 labelled as above, received in a locked box at 8:45 a.m., Friday, January 16, 1970.
A duplicate sample of #3 arrived broken.

C. Simpson, Analyst,
Supervisor, Chemistry I Branch.

10M-60-22690